

WAVEGUIDE DIRECTIONAL FILTERField of Invention

This invention relates to the technology of combining multiple UHF TV broadcasting transmitters on to a common antenna.

5 Background of Invention

In this technology it is known to provide a UHF filter/combiner system comprising an assembly of dual bandpass filters whose inputs and outputs are coupled by waveguide hybrid couplers. A disadvantage of this known system is its relatively large size. Another disadvantage of this system is that the dual bandpass filters
10 must be electrically identical, which is difficult to accomplish due to their complexity.

It is also known to provide a UHF filter/combiner that comprises a cascade of dual mode resonant cavities with input and output coaxial coupling elements, such as the "ROTAMODE" device. However, a disadvantage of this form of
15 construction is that the power handling capability of the coaxial input and output elements is limited.

It is also known to use a waveguide directional filter technique at microwave multi-point distribution system(MMDS) frequencies above 2GHz. Each TV channel at MMDS frequencies occupies a fractional bandwidth of much less than 1%.
20 However, at UHF broadcasting frequencies in the range 470-860 MHz, the fractional bandwidth of a TV channel is of the order of 1% or more, and a conventional waveguide directional filter does not provide a satisfactory electrical performance.

Summary of the Invention

25 It is an object of the present invention to provide a waveguide directional filter arrangement which can be used at UHF broadcasting frequencies, and avoids the disadvantages of the aforementioned prior art.

According to a first aspect of the invention there is provided a waveguide directional filter arrangement comprising an input waveguide means and an output
30 waveguide means connected by cavity resonator means, wherein said input waveguide means and said output waveguide means each include broad wall sections joined by narrow wall sections whose aspect ratio is greater than 2:1.

According to a second aspect of the invention there is provided a waveguide directional filter arrangement comprising an input waveguide means and an output waveguide means, wherein each said waveguide means includes an aperture means arranged to couple its associated waveguide means to a common resonator means, and wherein edges of each aperture means include inwardly extending sections.

According to a third aspect of the invention there is provided a waveguide directional filter arrangement comprising an input waveguide means and an output waveguide means connected by cavity resonator means comprising at least three stacked resonator elements, wherein at least one pair of non-adjacent resonator elements include additional coupling means to couple the non-adjacent resonator elements.

According to a fourth aspect of the invention there is provided a waveguide directional filter arrangement comprising an input waveguide means and an output waveguide means connected by a cavity resonator means comprising at least one resonator element, said input waveguide means and said output waveguide means each include broad wall sections joined by narrow wall sections whose aspect ratio is greater than 2:1, each said waveguide means includes an aperture means arranged to couple its associated waveguide means to said cavity resonator means, wherein edges of each aperture means include inwardly extending sections.

In highly selective bandpass filters which use adjacent cavity resonators coupled by apertures in common walls, the magnitudes of such couplings are very critical parameters.

In order to achieve these necessary critical parameters it is known to provide a high degree of manufacturing precision. However, this solution is unattractive for large filters.

It is therefore a further object of the present invention to provide an adjustable coupling aperture arrangement for adjusting the coupling of cavity resonators over a wide range of coupling values, the coupling being adjusted externally using a tool that does not disturb the filter's characteristics.

According to a fifth aspect of the invention, in a microwave filter comprising a housing within which is disposed at least two cavity resonators coupled by aperture means in a substantially planar wall common to both said resonators, there is provided an adjustable coupling aperture arrangement including aperture

5 means

comprising at least one slit of predetermined dimensions, the at least one slit communicating with a respective access hole in said housing via an associated passageway that lies within the boundary of said wall's major surfaces, wherein said at least one slit is provided with a moveable metal slug that is slideably

10 retained by opposite longitudinal edges of the slit, whereby said slug can be engaged and slideably manipulated by a tool means, introduced into said access hole and guided to said slug via said passageway, into a position in which electrical contact between said slug and said edges of the slit produces a desired change in effective electrical length of the slit.

15 Brief Description of the Drawings

In order that the invention may be readily carried into effect, embodiments thereof will now be described in relation to the accompanying drawings, in which:

Figure 1 shows a waveguide directional filter assembly of the present invention.

20 Figure 2 shows a more detailed view of the aperture arrangement of the assembly shown in Figure 1.

Figure 3 shows an alternative aperture arrangement.

Figure 4 shows a waveguide direction filter assembly with additional coupling between non-adjacent resonators.

25 Figure 5 is a top view of a cavity wall within a coaxial filter housing, the cavity wall being provided with an adjustable coupling iris.

Figure 6 is a top view of the cavity wall shown in Figure 5, showing radial passageways connecting slits of the coupling iris to the filter housing exterior.

Figure 7 is a side view of Figure 6.

30 Figure 8 is a top view of an expanded adjustment slug.

Figure 9 is a top view of a contracted adjustment slug.

Figure 10 is an end view of a adjustment slug.

Figure 11 is a side view of a cavity wall showing an adjustment slug located within a slit of the coupling iris.

Detailed Description

5 Referring to Figure 1, the assembly comprises an input waveguide 1 having a narrow band input port and an absorbing termination port; and an output waveguide 2 having a wideband input port and an output port. The waveguides are rectangular having broad walls 3 joined to narrow walls 4 whose aspect ratio is approximately 4:1.

10 Waveguides 1 and 2 are connected by six circularly cylindrical aperture coupled cavities 5. Coupling between adjacent cavities is provided by circular apertures 6.

Each end cavity is operatively coupled to its associated rectangular waveguide through a characteristically shaped aperture 7, 7a. Referring to Figure 15 2, aperture 7a, which is similar to aperture 7 in input waveguide 1, is in the form of a rectangle whose four sides have integral inwardly extending hemicycle sectors 8, 9, 10 and 11. These hemicycle sections provide increased coupling into the desired resonator mode.

It will be understood that the inwardly extending hemicycle sections can be 20 in the form of discrete elements, such as for example discs, that can be attached around the edges of a basic rectangular aperture. The position of such discrete elements can be made adjustable to vary the coupling through the aperture.

Alternatively, the inwardly extending hemicycle sections can be in the form of cylinders 12, 13, 14 and 15 as shown in Figure 3. As with the above mentioned 25 discs, the position of the cylinders can be adjustable to vary the coupling through the aperture. Moreover, the cylindrical form causes a greater reduction of coupling into undesirable modes.

Referring to Figure 4, non-adjacent resonator elements 16 and 17 of the waveguide directional filter assembly are provided with two additional coupling 30 elements 19 and 20. Each coupling element comprises two probes 21 and 22 connected by a transmission line 23. The probes extend into the resonators and are disposed at 90° to one another.

Sub B1
The power handling capability of the waveguide directional filter arrangement described above can be enhanced by the addition of cooling fins (not shown) on one or more of the cavity resonators.

5 Also, tuning elements (not shown) can be added to the cavity resonators.

In operation, a narrow band signal is injected into the input port of input waveguide 1. This signal is coupled through aperture 7 into the first cavity resonator and launches a circularly polarised wave therein which is coupled through successive circularly cylindrical resonators 5 by means of circular
10 apertures 6 to the output waveguide 2 via aperture 7a, where it produces a directional wave. This signal is added to any existing signals travelling through the same waveguide at other frequencies.

An absorbing termination coupled to waveguide 1 absorbs any power not coupled into the first resonator.

15 The reduced height of the waveguides improves the circularity of the circularly polarised wave in the resonators, which provides improved directional characteristics in the output waveguide across the operational band.

An advantage of the waveguide directional filter assembly of the present invention vis-a-vis the prior art assembly using separate hybrids and filters is that
20 the assembly of the present invention is relatively unaffected by temperature differentials which can occur between separate filters in a hybrid coupled configuration. Such temperature differentials lead to a degradation of performance.

Referring to Figures 5 and 6, the adjustable coupling aperture arrangement comprises an electrically conductive wall 24 coaxially located within a filter housing
25 25. Wall 24 is provided with a cruciform iris 26 comprising a central zone 27 having four slits 28, 29, 30 and 31 extending outwardly therefrom. Each slit is connected by a radial passageway 32, 33, 34 and 35 to respective apertures 25a, 25b, 25c and 25d in the filter housing permitting access to the slits from the exterior of the filter housing. The passageways are within the boundary of the wall's opposite
30 surfaces. In each slit is arranged a captive, movable, rectangular metal slug 36, 37, 38 and 39.

Referring to Figures 8 – 11, each rectangular slug comprises two sections A and B each in the form of general trapezoids whose respective non-parallel sides

40 and 41 interface. The two sections are held together by a screw 42. One section, A, is provided with a threaded hole (not shown), which cooperates with the screw's

5 thread when the screw is disposed in a bore hole in section B. The screw is provided with a slotted bayonet head 43 which allows the screw to be engaged by a tool (not shown) having a T-shaped end to allow the screw to be rotated as well as allowing the associated slug to be moved linearly.

10 A groove 44, 45 is provided in a side of each section A and B such that when a slug is assembled by screwing the sections together, opposite parallel grooves are formed for slidably engaging the edges of respective slits. Due to cooperation between sections A and B, the width between the sides provided with the grooves is maximum when the screw is tightened as shown in Fig. 8, and minimum when the screw is loosened as shown in Fig. 9. Referring to Fig. 11, the width is such that the slug is slidably retained in a slit when the screw is loosened, and fixedly grips and makes electrical contact with opposite edges of the slit when the screw is tightened, thereby affecting the electrical length of the slit.

15 In operation, slugs 36, 37, 38 and 39 are located in respective slits. Desired filter transmission and reflection characteristics are obtained, using a vector network analyser and manipulating the slugs with the tool inserted into respective passageways 32, 33, 34 and 35 via associated apertures 25a, 25b, 25c and 25d. While it is preferable to use four slugs to maintain symmetry in two principal planes, it will be understood that this is not an essential requirement.

20 Further, in filter arrangements where only a single slit is required, either one or two slugs could be used.